Magnitude of 64-m Elevation Axis Movements Due to Alidade Temperature Changes

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In projected very-long baseline interferometry (VLBI) work a reference point for 64-m antennas is the intersection of the elevation and azimuth axes. This report describes a minimum-level effort at DSS 14 to determine the magnitude of the effect of diurnal changes in the temperature of the alidade legs on the height of the elevation axis. The thermal expansion between the lowest recorded temperature −3°C (27°F) and the highest, 36°C (97°F), over the period covered was 8.9 mm (0.35 in.).

I. Introduction

In projected VLBI work a reference point for 64-m antennas is the intersection of the elevation and azimuth axes. This report describes a minimum level effort at DSS 14 to determine the magnitude of the effect of diurnal changes in the temperature of the alidade legs on the height of the elevation axis. The results, over a period from March through September, 1976, show an average height change of 1.70 mm (0.07 in.) during a day, with a range from 0.1 mm (0.004 in.) to 3.5 mm (0.14 in.) for the period covered. The thermal expansion between the lowest recorded temperature −3°C (27°F) and the highest, 36°C (97°F), over the period covered was 8.9 mm (0.35 in.).

II. Test Instrumentation

Alidade temperature measurements were made using surface thermometers placed on an inner surface (to avoid direct sunlight) of the front alidade legs (Figs. 1 and 2). Initially, thermometers were placed on the right front leg. After one month's data were taken, one of the thermometers was moved to the left leg to determine if the temperatures there were significantly different.

The alidade leg and ambient temperature readings were recorded three times each day by maintenance personnel, generally at 0600, 1200, and 2000 hours. The temperature readings for the right leg were averaged, and the differences between the high and low reading for these data and for the left leg and ambient temperatures were tabulated. The results were then reduced statistically, and are shown for each month in Table 1. The dimensional change is based on a length of 20.96 m (835 in.), the distance from the elevation bearing to the machinery deck level, and a coefficient of thermal expansion of $1.08 \times 10^{-5}/^{\circ}C$ ($6 \times 10^{-6}/^{\circ}F$).

III. Conclusions

The maximum elevation change of the elevation axis measured during one day was 3.5 mm (0.14 in.). The maximum change over the period of record was 8.9 mm (0.35 in.). These numbers may be useful in evaluating methods for monitoring the position of the axis intersection.

The precision of the results obtained is seriously limited by the limited number of data points for each day. The use of continuous recording equipment would provide much more accurate information, but at a considerable cost in instrumentation and data reduction. The need for this must be defined before such a program is undertaken.

An accurate correlation between temperature measurements and elevation position was beyond the scope of this effort. The use of temperature measurements as an element in determining the position of the elevation axis would require considerable development effort, if practical.

Table 1. Changes in alidade leg temperature, length, and ambient temperature

Month, 1976	Right leg		Left leg		Ambient
	ΔT, °C (standard deviation)	Δh, mm (for average Δt)	Average ΔT, °C (standard deviation)	Δh, mm (for average Δt)	ΔT, °C (standard deviation)
Mar.	7.58 2.83	0.017			
Apr.	7.82 3.46	0.018	6.50 3.73	0.15	
May	8.54 3.57	0.20	7.82 3.23	0.18	9.77 4.70
Jun.	7.62 3.31	0.17	5.96 3.50	0.14	9.59 3.94
Jul.	7.51 3.23	0.17	5.69 2.88	0.13	9.82 4.46
Aug.	8.31 3.07	0.19	6.91 2.35	0.16	10.80 3.28
Sep.	5.08 2.81	0.12	4.55 2.44	0.10	7.65 3.27

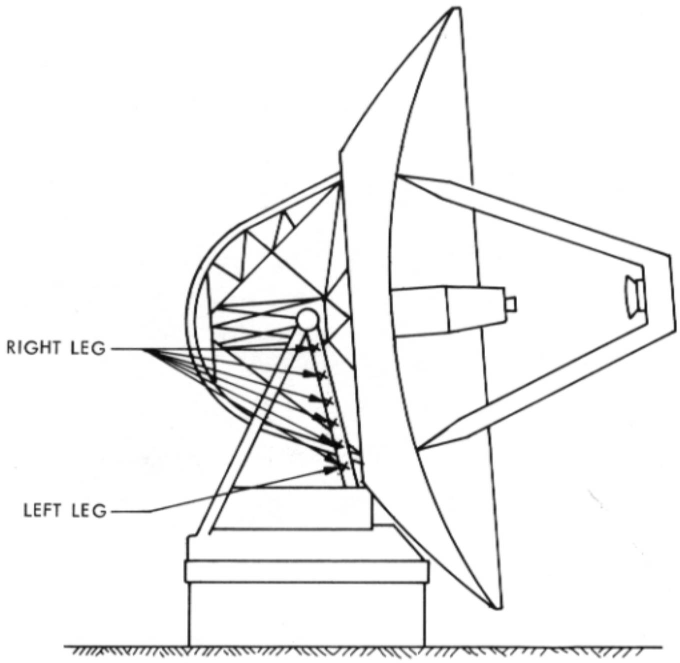

Fig. 1. Thermometer locations on alidade leg

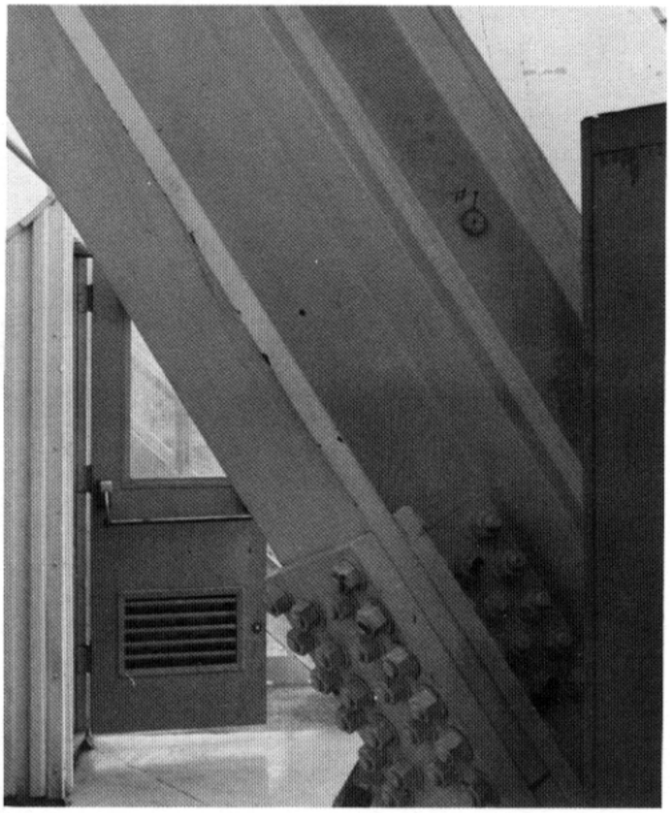

Fig. 2. Typical thermometer location